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ABSTRACT

In the 1980-81 school year, the Title I program in Lafayette Parish, Louisiana, initiated research into the effectiveness of computer-assisted instruction (CAI) for mathematics in grades 3-6. Children from two lower socioeconomic area schools, who were one or more years below grade placement but were already making gains of 6-9 months due to an effective pull-out math lab took part in the CAI study. Students from both schools were matched, and members of matched pairs were randomly assigned to either the CAI group of non-CAI group. Both groups continued to receive standard math lab instruction, the experimental group received 10 minutes of daily CAI. Pre- and post- evaluations showed educationally meaningful grade achievement gains and grade equivalent gains for the CAI group. Though not as rigourously controlled, data from the previous year concurred with the 1980-81 results. Funding cuts in 1981-82 brought an end to the math lab for Title I students (grades 5-8) who, in addition to regular classroom instruction, were now given 10 minutes of daily CAI drill. Gain scores were superior to the gains made in the experimental program of 1980-81. There was no comparison group, however. In 1982-83, results for all students were obtained in a standard score format, and comparison data from the State and nation were obtained. Results demonstrated stable, sizeable, and meaningful gains for CAI students, as compared with non-CAI students in Lafayette Parish and with State and national results, showing that daily CAI practice enhances the process of remediation. (CMG)

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COMPUTER ASSISTED INSTRUCTION AS AN ENHANCER OF REMEDIATION

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In the 1980-81 school year, the Lafayette Louisiana Title I program initiated a research program into the effectiveness of computer assisted instruction (CAI) for mathematics in grades 3-6. An effective pull-out (from the regular classrrom) mathematics laboratory already existed which produced 6 to 9 months of progress in children who were one or more years below grade placement. Two lower socioeconomic area schools, of a possible fourteen, were selected for the research program.

The CAI program was devised by Computer Curriculum Corporation, Palo Alto California (a complete description can be obtained from the company or from Lafayette Louisiana school system). The program arranges items in order of difficulty and includes the domain of materials specified in major textbooks used in the United States. Each ten minutes lesson contains a mixture of different type problems, and the computer automatically adjusts the level continuously upward or downward to provide a student with the necessary level of difficulty to produce seventy-five percent mastery.

Students in grades 3 to 6 within the two experimental schools were matched, based on the past spring's math standard score for the CTBS/McGraw Hill Criterion Referenced Achievement Test (normed April, 1975, with an average reliability of .85 for CTBS Levels 1 and 2 From T) at the beginning of the September 1980-81 school year. Each member of the matched pair was randomly assigned to either the CAI group or non-CAI group. All students continued to receive standard math lab

instruction, but the experimental group received ten (10) minutes of daily CAI.

The month of September was used as a period of stabilization and adjustment for all students. At the beginning of October, independently trained psychometricians administered the CTBS/McGraw Hill to both experimental and comparison group students. A double blind procedure was used with the examiners totally unaware of whether a student was in the experimental or comparison group. Pre-tests were scored and tabulated by the examiners. The post-evaluation was performed by trained examiners in the first week of April. The time between pre and post evaluation was six (6) months; if Christmas and other holidays are discounted, the time was approximately five and one-half (5½) months or one hundred and nine (109) days of instruction.

Table 1 presents the pertinent descriptive data for the CAI and non-CAI groups. It can be observed that the groups are comparable on pre-evaluation variables. The post standard score data favored the CAI group. The post grade placement achieved and grade equivalent gain scores are presented for observational purposes, though their deficiencies are acknowledged. Even with their limitations, these two measures favor the CAI group. Table 2 contains an ANOVA summary table with post standard scores as the dependent variable and pre-standard scores as a covariate. It is noted that CAI instruction is significantly superior to non-CAI, $F(1,180)=6.73$, $p < .01$.

This study illustrated that CAI added a significant standard score gain above and beyond that made by standard lab instruction. Examination of the grade achievement gains and grade equivalent gains implies that this increment is educationally meaningful and valuable.

The computer provides a means for drilling in basic math in an intriguing, interesting way, adding a dimension to what an instructor provides in the classroom or math laboratory. The organization of information exchange in even a ten minute segment is proportionally

TABLE I
MEANS AND STANDARD DEVIATIONS FOR COMPUTER ASSISTED INSTRUCTION WITH MATH LAB FOR GRADES 3 to 6

(N = 94; Males = 50; Females = 44)

	MEANS	S.D.
Pre CTBS Standard Score	364.43	50.05
Pre Grade Placement Achieved	4.07	1.17
Age	10.90	1.27
Post CTBS Standard Score	402.86	47.77
Post Grade Placement Achieved	5.09	1.20
Grade Equivalent Gain	1.01	.86
Range of Grade Equivalent Gain	-1.0 to +2.9	

MEANS AND STANDARD DEVIATIONS FOR NON-COMPUTER ASSISTED INSTRUCTION WITH MATH LAB FOR GRADES 3 to 6

(N = 96; Males = 54; Females = 42)

Pre CTBS Standard Score	362.32	53.16
Pre Grade Placement Achieved	3.97	1.29
Age	11.00	1.52
Post CTBS Standard Score	391.21	50.58
Post Grade Placement Achieved	4.83	1.33
Grade Equivalent Gain	.88	.69
Range of Grade Equivalent Gain	-.9 to +2.6	

TABLE II
ANOVA of Post Math Standard Scores
for CAI Versus NON CAI
with Pre Math Rawscores as a Covariate for
Grades 3 to 6

SOURCE	SS	DF	MS	F
Pre Math Standard Score (Covariate)	318887.07	1	318887.07	474.12^{xx}
Computer - Non Computer	4523.92	1	4523.92	6.73^{x}
Error	121065.01	180	672.58	
Total	444476.00	182	2442.17	

$^{xx}p < .001$
$^{x}p < .01$

great. Adding computer time might bring even greater gain or possibly produce boredom. An empirical investigation of this issue is recommended.

Though not as rigorously controlled, data from the previous year 1979-80 concurred with the above results. The average rawscore gain of two hundred twenty-two (222) students for CAI in 1979-80 was 16 which concured with the CAI gain for 1980-81. The present investigation's strength lies in the rigorous matching of the experimental and comparison groups. The CAI experimental group and the comparison group made progress; therefore, the additional gain of the experimental group is a very powerful result since both groups of students were receiving the enrichment of math lab instruction.

In the 1981-82 school year, funding cuts demanded lessening of Title I services. In the Lafayette Louisiana school system, regular classroom teachers were instructed to individualize instruction in all

elementary classrooms. Although inservice training and workshops were provided to facilitate this procedure, each teacher was allowed a great deal of autonomy in implementation of curriculum adjustments for disadvantaged children. It was decided that Title I children were to remain in their regular classroom for math instruction and receive 10 minutes of CAI drill everyday of the school year. Considering the CAI gains of the previous two years, a decision was made to provide CAI for students in 5th, 6th, 7th, and 8th grades. Table III contains the SRA Spring to Spring gains for a random sample of 100 students at each grade

TABLE III
SRA Grade Level Equivalent Gains

Grade	N	Gain
5	100	1.25
6	100	1.24
7	100	1.04
8	100	1.19
Total	400	1.18

level. These gain scores are superior to the gains made in the experimental program described above for 1980-81. Standard score comparisons were unfortunately not made and there was no comparison group. However, these children were 1½ or more years behind in arithmetic ability, and certainly made meaningful gains.

Table IV presents gain scores derived from the CAI program, with pre obtained in October and post in May. Again standard scores were not retrieved. The sample of students for CAI gains overlaps but is not totally the same as the SRA data. The CAI data concurs

TABLE IV
CAI Grade Level Equivalent Gains

Grade	N		Gain
5	51		1.25
6	169		1.31
7	123		1.23
8	125		1.65
	Total 468	Average	1.43

with the SRA in demonstrating that ten minutes of CAI drill added to regular classroom instruction helped remedial students make significant academic progress.

Encouraged by these results for 1981-82, the program was continued in the 1982-83 school year. Ten minutes of CAI were provided to each Title I student. Regular classroom instruction in arithmetic was maintained as described above for 1981-82. It was decided that results for all students would be obtained in a standard score format. NCE's were chosen as the standard score since they have been extensively used in Title I research. Comparison data for the state of Louisiana and the United States were obtained.

Table V presents the results for the 1982-83 school year. The NCE SRA gains are all significant except for sixth grade. It may be that the very high gain recorded in fifth grade limited the possible sixth grade NCE gain due to artifacts of the SRA fifth and sixth grade items. The CAI grade equivalent gain for sixth grade implies that the sixth

TABLE V
1982-83 Arithmetic Progress

Grade	N	NCE SRA Gain	CAI Grade Equivalent Gain
5	115	15.0	1.82
6	172	.5	1.84
7	171	7.4	1.96
8	137	6.6	1.94
5 - 8	596	6.7	1.89

graders did as well as the other grades. Even acknowledging that grade equivalent gains may be somewhat inprecise, the CAI gains are very stable, sizable, and meaningful. A gain of 3 NCE's is usually considered significant. In order to compare the 1982-83 gains to appropriate data, national and state results were retrieved for similar populations. National results on comparable populations were only available for 1979-80 and state results for 1980-81 and 1981-82.

Table VI provides a comparison of NCE gains. The data demonstrates that the Lafayette program is clearly superior when comparisons of SRA NCE gains are made. Computer assisted instruction provides an important vehicle for learning arithmetic skills. Ten minutes of CAI practice per day enhances the process of remediation. It is estimated that a child can work on sixty basic math problems in ten minutes using computer

TABLE VI
Comparison of NCE Gains
for Title I Children

		N	Grades	
Lafayette, LA	1982-83	596	5-8	6.7
United States	1979-80	750,000(est.)	5-8	2.9
State of LA	1981-82	3,840	5-8	1.2
State of LA	1980-81	6,796	5-8	-.9

presentation. The computer adjusts the problems to the skill level of the child. A weekly performance print out determines daily progress. Conceptual deficits are identified and the classroom teacher can provide instruction in the problematic area.

In a total school year a child spends approximately 22.50 hours on the computer. The rate of gain (in grade equivalents) per hour is approximately .085. It is extremely important to maintain orderly

schedules so that each child gets a full ten minutes of computer practice. Gain is demonstrated to be proportional to time on the computer.

CAI is provided in reading for Title I children. All Title I children receive remedial reading instruction in a diagnostic prescriptive format for 50 minutes a day. They also receive 10 minutes of CAI. Initial experimental results (1980-81) were unable to prove that the addition of CAI instruction in reading was superior to remedial instruction alone. However, data for 1982-83 on 814 children in grades 5-8 produced an average SRA NCE gain of 4.1, an average SRA grade equivalent gain of 1.3 and an average CAI grade equivalent gain of 1.3. The U.S. average gain for grades 5-8 is 2.3 for 1979-80 and Lafayette Louisiana is therefore doubling the national average. These reading gains are all significant and meaningful but are less powerful and definitive than the arithmetic gains. Research on CAI for reading is continuing, to set up an ideal plan for maximum gain.